Dynamic Line Rating Testbed Study Using Weather Forecasting

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BACKGROUND

Dynamic Line Rating (DLR) is a technology that calculates the instantaneous maximum current (ampacity) of a transmission line by using ambient weather conditions. Traditionally, conductors are assigned static thermal ratings (STR) which are highly conservative and can be dangerous when the ampacity is less than the STR. Hence, DLR is a safer alternative to STR and a solution that can help with curtailment of renewables and the economy when supplied with forecast weather conditions.

OBJECTIVE

The objective of this study is to observe the effects on the ampacity of Idaho National Laboratory (INL) overhead transmission lines when using various percentages of the High-Resolution Rapid Refresh (HRRR) forecast model points at near term (3-hour) forecasts.

METHODS

Ampacity curves for overhead conductors in the INL desert site over a two-year period were generated as follows:

- Identify transmission lines of interest.
- Specify the computational fluid dynamics (CFD) domain and obtain the digital elevation model data.
- Identify the HRRR model point locations closest to the transmission lines.
- Extract the HRRR model point data containing ambient temperature, wind velocity, and solar irradiance over a two-year period.
- Run the CFD simulations for the region.
- Extract the tables for mapping wind speed and direction values from the HRRR model point locations to the transmission line segment midpoints.
- Create configurations to select data from differing percentages of HRRR model points in the region.
- Calculate the ampacity along the transmission lines at the midpoints of every line segment and select the minimum at each point in time using INL's General Line Ampacity State Solver (GLASS).

RESULTS

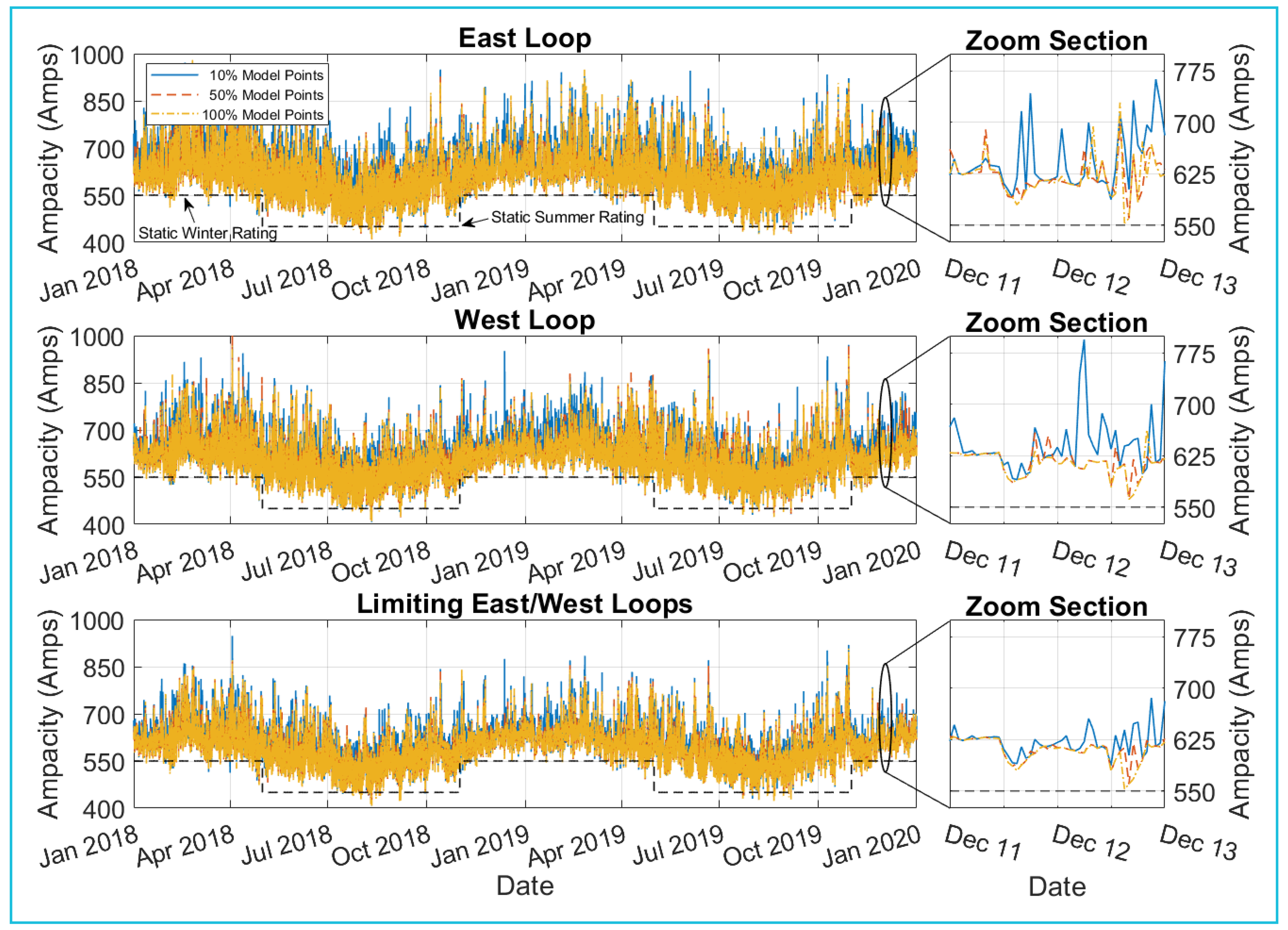

Figure 1: STR versus DLR using 10%, 50%, and 100% of the model points from 2018 to 2020 for limiting ampacities of the east loop (top), west loop (middle), and out of both loops (bottom).

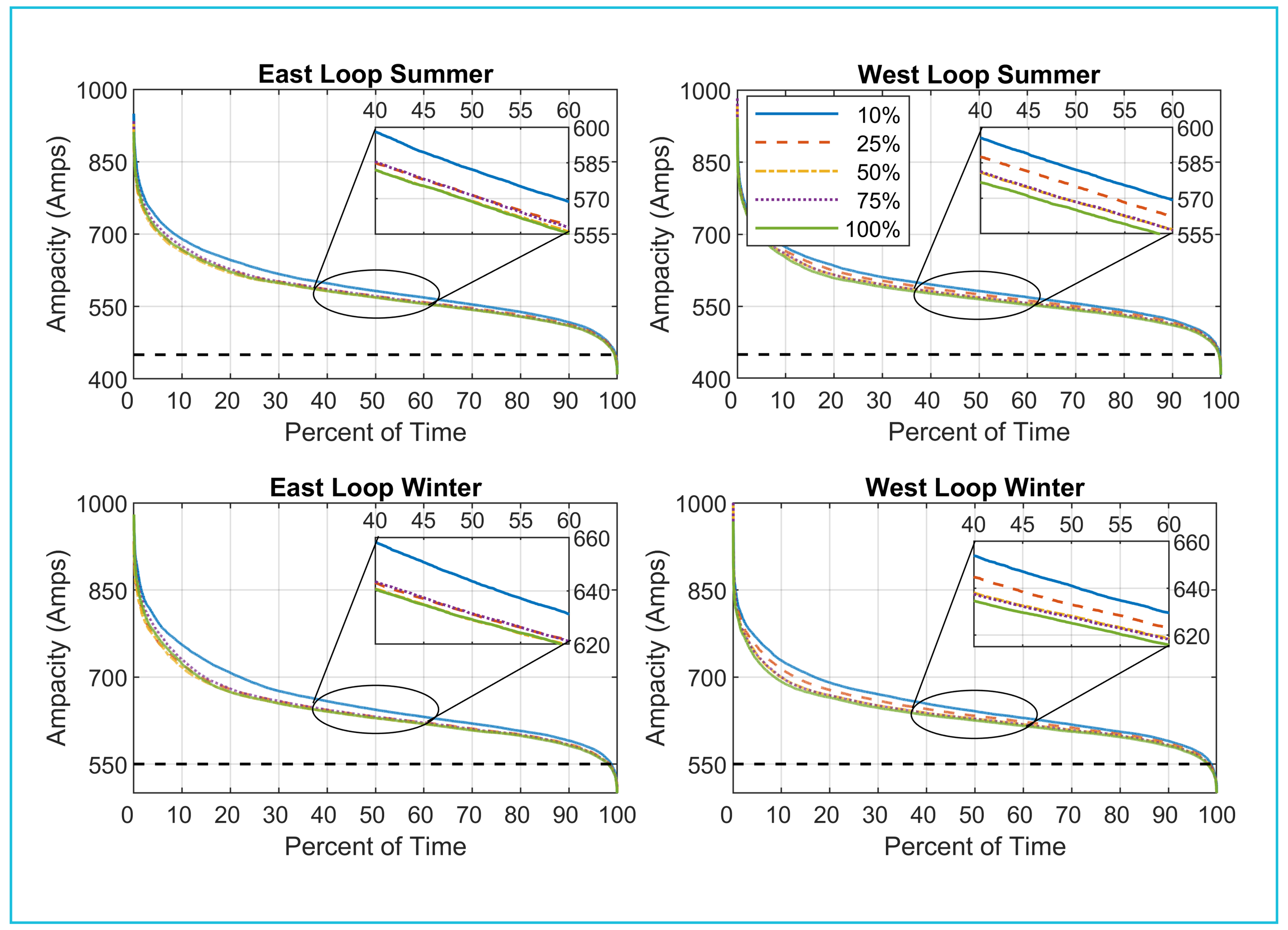

Figure 2: Frequencies of STR and DLR using 10%, 25%, 50%, 75%, and 100% of the model points from 2018 to 2020 for limiting ampacities of the east and west loop in the Summer and Winter.

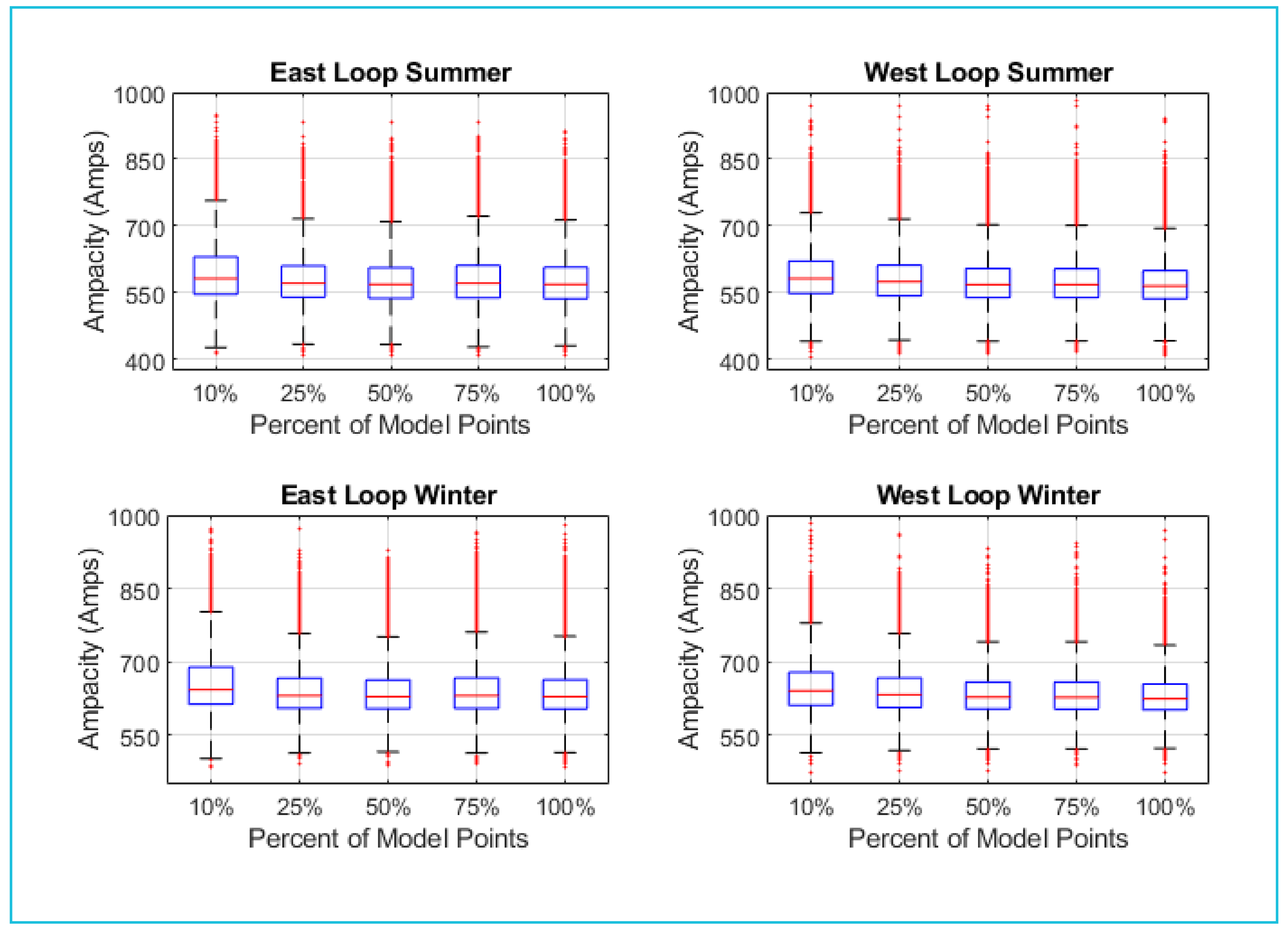

Figure 3: Box plot distributions of the ampacities of the east and west loop in the Summer and Winter as the percentage of model points is increased.

Amp-Hour Metrics

Model Point Percentage	STR Amp Hours	EL Amp Hours	WL Amp Hours	EL – STR Amp Hours	WL – STR Amp Hours
10%	4.380 MA-h	10.975 MA-h	10.872 MA-h	6.595 MA-h	6.492 MA-h
25%	4.380 MA-h	10.724 MA-h	10.739 MA-h	6.344 MA-h	6.359 MA-h
50%	4.380 MA-h	10.675 MA-h	10.631 MA-h	6.295 MA-h	6.251 MA-h
75%	4.380 MA-h	10.696 MA-h	10.611 MA-h	6.316 MA-h	6.213 MA-h
100%	4.380 MA-h	10.688 MA-h	10.565 MA-h	6.308 MA-h	6.185 MA-h

Table 1: Total amp-hour metrics for two-year period of the STRs and DLRs of the east and west loop as the percentage of model points is increased. Differences between DLR and STR are in the shaded region.

CONCLUSIONS

Weather forecasts are a crucial component to realizing DLR in a transmission system because real-time observations can not be used in the energy market when assigning prices. Overall, the forecast model points used in this study were shown to yield more conservative DLRs as the density of model points in the study region was increased. This is highly dependent on the quality of the forecast weather data seen in the model points. Regardless, DLR still showed higher capacity for overhead conductors in the INL desert site than STR by more than six mega-amp hours in each case.

ACKNOWLEDGEMENTS

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